WATEROUS

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Fire Pump Performance – General Information

Engine Data

The following procedure may be used to estimate power available for either a gasoline or diesel engine:

NOTE: For pump/engine combinations that may be marginal, we recommend contacting the engine and/or chassis manufacturer to more accurately determine engine performance.

1. Determine full–load and/or no load governed speed (from manufacturer's certified power curve).
2. Refer to transmission rating chart, Waterous form number F–1052, select a pump ratio that will permit operation within the transmission load range at an engine speed not exceeding full–load governed speed. It is desirable not to exceed 95% of the full load governed speed.
3. Determine the net horsepower/kilowatts of the engine at the engine speed required for the ''critical'' pumping condition(s). To accomplish this, determine the ''critical'' test from the performance sheets or curves for the selected pump and capacity rating considering maximum horsepower/kilowatts and maximum rpm required. As an example:

   Usually the ''critical'' test for both power and rpm for a two stage pump is the 100% capacity at 165 psi/11.4 bar test, unless booster reel or other performance required by the customer will demand a higher rpm. (For example, see performance sheet F–1146.) However, the 70% capacity test could be the ''critical'' test for rpm if run in parallel.

   The ''critical'' rpm test for a single stage pump is always determined by the maximum pressure at which the pump is required to operate; however, the ''critical'' horsepower/kilowatts test will vary depending upon pump model and capacity range and required booster reel or other performance. (For example, see performance sheet F–1179.)
4. After determining the net engine power available from the engine manufacturer's certified power curve at the engine speed required for the ''critical'' pumping conditions you wish to check, consider horsepower/kilowatts losses for engine accessories and engine variance not shown on the engine curve, and deduct this power loss from the net engine horsepower/kilowatts available.

   Unlike engine manufacturers who may not dynamometer test each production engine, we do dynamometer test each pump before shipment. We allow variations of 3% on rpm and 5% on power consumption because of production tolerances, and guarantee that any pump shipped will not exceed these variances at time of shipment. We cannot guarantee power availability of any engine. We can however provide general guidelines which we have found satisfactory:

   ENGINE POWER CURVES – Power curves usually represent ''as installed'' power available at the engine crankshaft and have all parasitic loads deducted. These parasitic loads normally are fan, exhaust system, alternator, air compressor, fuel pump, oil pump, etc. Some power curves however, do not represent ''as installed'' power; therefore, additional parasitic load deductions may be necessary. Examine power curves carefully to determine whether it represents ''as installed'' power, or if not, what parasitic loads have been included.

   Most diesel engine manufacturers certify that they will guarantee power output within 5% as represented by the certified power curve. Therefore, you may need to deduct only 5% from the ''as installed'' power curve to determine guaranteed power availability at the engine crankshaft at any specific rpm for engines certified within 5%.

   Conversely, the gasoline engine manufacturer's certified power curves do not make a specific guarantee of power availability. Therefore it is necessary to deduct more than 5% of the ''as installed'' power curve to be safe. For estimated percentage deductions against engines that do not represent ''as installed,'' see Waterous engine/pump ratio work sheet:

   - Diesel Engines – F–2102
   - Gasoline Engines – F–2103

   Some engine manufacturers issue special certified power curves for fire apparatus use, and these should be used whenever possible.

5. **Environmental Deductions:**

Power availability of an engine may be reduced when the altitude and/or the ambient air temperature exceeds the certified power curve rating conditions.

Diesel engine power curves generally show certified performance to include maximum altitude and ambient temperature. When altitude and/or ambient temperature does exceed the certified ratings as shown on the engine power curve, appropriate horsepower/kilowatts deductions must be computed. Contact the engine manufacturer for deration figures.

6. **Automatic Transmission Deductions:**

We have been advised by Allison that the MD and HD transmissions will consume varying amounts of power at various rpm in high range lockup. Figures listed below represent power consumption, input to output, reflecting the charging pump losses, friction losses, positive lubrication, etc. They are representative with the transmission in 1.0 ratio (4th or 5th depending on model), converter locked–up, and will be approximately constant regardless of input power. Figures are taken from actual test data and are nominal:

RPM	MD–3060 Series	HD–4060 Series
1000	3 hp / 2.2 kW	7 hp / 5.2 kW
1500	4 hp / 3.0 kW	11 hp / 8.2 kW
2000	6 hp / 4.5 kW	16 hp / 11.9 kW
2500	8 hp / 6.0 kW	–
3000	10 hp / 7.5 kW	–

If you are driving the fire pump using a midship pump transmission, this power loss must be deducted from the net horsepower/kilowatt available from the crankshaft after all previous deductions have been made. Fire pumps driven by flywheel PTOs, chassis transmission PTOs or from the front of the engine with the automatic transmission in neutral do not require this deduction from engine power.

7. **Example of Pump/Engine Calculations:**

CMYB–1000:

71796 – 71797 Impellers – *Since the 70% capacity test on this pump rating with these impellers is normally done in series, the ‘‘critical’’ test is 1000 gpm @ 165 psi (3785 L/min @ 11.4 bar) for both power and rpm.

Pump Transmission Ratio:

2.27 (See Gear and Clutch Rating Chart, F–1052.)

“Critical” Pump Test:

1000 gpm @ 165 psi, 3795 rpm, 142 hp (3785 L/min @ 11.4 bar, 3795 rpm, 105.9 kW) (See performance sheet F–1146.)

Altitude at Destination:

2000 ft (609.6m)

ENGINE:

Model:

6V92TA DDEC

Gross Output:

BHP = 350 @ 2100 rpm (BkW = 261 @ 2100 rpm)

TRANSMISSION:

Allison Automatic Transmission (HD–4060 Series)

CALCULATION:

Pump Impeller Shaft rpm 3795 ÷ 2.27 = 1672 engine rpm

Power available = 314 gross engine hp (234 gross engine kW) from engine power curve

A.	Gross hp available (from curve)	314	234.1
B.	15% engine variance deduction (314 x .15 = 47.1) (234 x .15 = 35.1)	–47.1	–35.1
C.	A minus B (engine crankshaft hp available at 2000 ft (609.6m) altitude)	266.9	199.0
D.	Altitude deduction (altitude capability of engine is 12,000 ft (365.8m), no deduction)	– 0	– 0
E.	C minus D (engine crankshaft hp/kW available at destination altitude)	266.9	199.0
F.	Temperature deduction for 77° F (25° C) air (none required)	– 0	– 0
G.	E minus F (engine crankshaft hp/kW available at destination altitude at 77° F (25° C) air temperature)	266.9	199.0
H.	Automatic truck transmission power loss deduction	–13	–9.7
I.	G minus H (horsepower available at transmission output shaft at destination altitude and 77° F (25° C) ambient air temperature)	253.9	189.3
J.	*Pump hp/kW required plus 5% maximum variation (142 hp x 1.05 = 149 hp) (105.9 kW x 1.05 = 111.2 kW)	–149	–111.2
K.	Estimated surplus horsepower/kilowatts remaining	104.9	78.1

Maximum pressure to booster reel at 60 gpm / 227.1 L/min flow: 2100 rpm x 2.27 = 4767 impeller rpm = 580 psi / 40 bar (from impeller performance curve)

*See impeller performance curve(s), or for your convenience, NFPA rated test data is listed on performance sheets with corresponding speed and horsepower/kilowatts requirements.

Performance Data

1. The data shown on performance sheets and curves is based on net pump pressure as required by NFPA 1901. Net pump pressure is the discharge pressure minus the intake pressure if the intake pressure is above atmospheric pressure as is usual when operating the pump supplied from a hydrant. Net pump pressure is the discharge pressure plus the intake pressure if the intake pressure is below atmospheric pressure, as when operating the pump from draft.

   Example:

   A. With pump operating from hydrant, discharge pressure gauge is reading 150 psi/10.3 bar; intake pressure (compound gauge) is reading 20 psi/1.4 bar; the net pressure is 130 psi/9.0 bar.

   B. With pump operating from draft, discharge pressure gauge is reading 145 psi/10 bar, intake pressure (compound gauge) is reading 10 inches of mercury (Hg). 10 inches Hg is equal to 5 psi/.3 bar; net pump pressure is 150 psi/10.3 bar.

2. Pump speeds may vary 3% above or below those shown on performance sheets and curves.
3. Horsepower/kilowatts may vary 5% above or below the values shown on performance sheets and curves.
4. Pump speeds may be slightly higher when lift or altitude approach the maximum.
5. The lift and altitude performance data shown represent average performance of a large number of pumps tested with variety of configurations of intake fittings. Actual pump performance may vary from performance shown. All pumps will meet the standard requirements of NFPA 1901. Pumps which must meet special performance requirements can be supplied but orders must specify the required performance.